

CONSIDERING CONTROL OF INVASIVE BARRED OWLS TO BENEFIT CALIFORNIA SPOTTED OWLS: POSSIBLE JUSTIFICATION AND DRAFT METHODS

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Abstract: Barred owls (*Strix varia*) recently expanded their range from eastern to western North America and are negatively affecting site occupancy, reproduction, and survival of federally threatened northern spotted owls (*Strix occidentalis caurina*), thereby confounding the land-based conservation strategy for northern spotted owls. Barred owls are moving southward into the range of non-federally listed California spotted owls (*S. o. occidentalis*), but are not, at this time or in the foreseeable future, a threat to the California spotted owl population. We recommend consideration of barred owl control in the northern Sierra Nevada Mountains while barred owl numbers are low enough to efficiently eliminate the possibility that they negatively affect California spotted owls outside of the foreseeable future.

Key Words: barred owl, invasive species, spotted owl, *Strix occidentalis*, *Strix varia*.

Managing Vertebrate Invasive Species: Proceedings of an International Symposium (G. W. Witmer, W. C. Pitt, K. A. Fagerstone, Eds). USDA/APHIS/WS, National Wildlife Research Center, Fort Collins, CO. 2007.

INTRODUCTION

The California spotted owl (CSO, *Strix occidentalis occidentalis*) is the only subspecies of spotted owl that is not federally listed as threatened or endangered. CSOs are found in the Sierra Nevada Mountains of California and the mountains of southern California. Their range is situated geographically between that of the northern spotted owl (NSO, *S. o. caurina*), which ranges from British Columbia to northwestern California, and that of the Mexican spotted owl (*S. o. lucida*), which ranges from southern Utah and Colorado through Arizona, New Mexico, and Mexico. The NSO was listed as federally endangered in Canada in 1986 (Campbell and Campbell 1984, Government of Canada 2002) and as federally threatened in the United States under the Endangered Species Act (16 USC 1531 et seq.) in 1990 (USFWS 1990). The Mexican spotted owl was listed as federally threatened in the United States in 1993 (USFWS 1993). The CSO was identified as a "sensitive species" by the U.S. Forest Service (USFS) in the early 1970s (Beck and Gould 1992) and as a "species of special concern" by the State of California in 1978 (CDFG 1978).

Barred Owls (*Strix varia*) expanded their range from eastern to western North America, are negatively affecting NSOs (as described below),

and are moving into the range of CSOs. Here we suggest consideration of barred owl control in the northern Sierra Nevada Mountains and methods to do so before barred owls increase in number, expand their range, and negatively affect CSOs.

CONSERVATION OF THE NSO

Successful litigation prior to listing the NSO as a threatened species, protections under the Endangered Species Act after listing, and designation of approximately 2.8 million ha of critical habitat in western Washington, western Oregon, and northwestern California (USFWS 1992) significantly decreased timber harvest on federal lands within the range of the NSO during the early 1990s (Charnley 2006, Thomas et al. 2006). Interagency groups of biologists (Thomas et al. 2006) produced conservation strategies for the NSO (Thomas et al. 1990, Johnson et al. 1991, Thomas et al. 1993) during the early 1990s that culminated in the Northwest Forest Plan in 1994 (USDA and USDI 1994) in an attempt to conserve NSOs and other late-successional species while permitting some timber harvest on federal land. Of the 9.9 million ha of federally owned lands managed under the Northwest Forest Plan, 30.4% (3.01 million ha) was designated as Late-Successional Reserves to protect forests used by

NSOs, 10.7% (1.06 million ha) was designated as riparian reserves in large part to allow dispersal of NSOs among Late-Successional Reserves, 6.0% (0.60 million ha) was withdrawn for administrative purposes, and 23% (2.27 million ha) was designated as Matrix and Adaptive Management Area to remain available primarily for timber harvest (USDA and USDI 1994, Marcot and Thomas 1997). Harvests were permitted in younger forests in Late-Successional Reserves and riparian reserves when they were designed to enhance attainment of old-forest characteristics. A total of 29.9% (2.96 million ha) of the federal land included in the Northwest Forest Plan remained as National Parks or wilderness areas. Overall, “the federal forests in the Pacific Northwest underwent the largest shift in management focus since their creation” (Thomas et al. 2006)—from timber production to protection of late-successional forests used by NSOs and other species. As the basis of the Northwest Forest Plan, “no species in the United States has had a greater impact on land-use planning at the landscape scale” than the NSO (Noon and Blakesley 2006).

INVASION BY BARRED OWLS

An invasive species, the barred owl, recently confounded this land-based conservation strategy. Historically, barred owls were distributed only in North America east of the Great Plains (Mazur and James 2000). Barred owls began their range expansion westward beginning more than 100 years ago according to early reports (K. Livezey and T. Fleming, unpublished data). The range expansion apparently was facilitated in large part by increased distribution of trees in the northern Great Plains (K. Livezey, unpublished data). Barred owls are now found in southern Canada from the Great Plains westward, in the Rocky Mountains of Idaho and Montana, and along the Pacific coast from southeastern Alaska to central California. They were first documented in British Columbia in 1943 (Rand 1944), Washington in 1965 (Rogers 1966), Oregon in 1974 (Taylor and Forsman 1976), and California in 1976 (B. Marcot, personal communication). The range of the barred owl now overlaps the entire range of NSOs in British Columbia (Hobbs 2005), Washington (Buchanan 2005), Oregon (Kelly and Forsman 2003), and northwestern California (see below).

Barred owls increased in number quickly throughout the range of the NSO. Two examples have been well documented. In Cowlitz Valley

Ranger District of Gifford Pinchot National Forest in Washington, numbers of barred owl detections increased 8.6% annually from 1982–2000 (Pearson and Livezey 2003); more recently, the 98 barred owl sites known in 2001 increased to 143 occupied sites by 2006, thereby outnumbering the 111 sites known to be occupied by NSOs by 29% (Pearson and Livezey 2007). In Redwoods National and State Parks in California (K. Schmidt, personal communication), there were 36 NSO sites and 15 barred owl sites in 1995. By 2006, the situation essentially was reversed: there were 17 occupied NSO sites and 36 barred owl sites. We are not aware of an estimate of total numbers of barred owls in the Pacific Northwest. However, barred owls apparently outnumber NSOs within the specific range of the NSO in British Columbia and Washington and they greatly outnumber NSOs throughout western Washington, western Oregon, and northern California due to their large numbers in many locations where there are no NSOs (e.g., the Puget Sound area) or very few NSOs (e.g., southwestern Washington).

Barred owls negatively affect NSOs in several ways. Barred owls occasionally hybridize with spotted owls (Hamer et al. 1994, Haig et al. 2004, Kelly and Forsman 2004, Seamans et al. 2005), but this behavior is considered to be an “inconsequential” phenomenon that takes place mostly when barred owls move into new areas, and declines as barred owls become more numerous and have more access to other barred owls (Kelly and Forsman 2004). Barred owls are larger than NSOs, are physically aggressive toward them (E. Forsman, J. Mowdy, T. Snetsinger, G. Stagner, personal communication), apparently can kill them (Leskiw and Gutiérrez 1998), and use the same habitats and prey as they do (e.g., Hamer et al. 2001, Gremel 2005, Livezey 2007). Correlational analyses strongly suggest that barred owls negatively affect calling behavior (Olson et al. 2005, Crozier et al. 2006), site occupancy (Kelly et al. 2003, Pearson and Livezey 2003, Gremel 2005, Olson et al. 2005, Pearson and Livezey 2007), fecundity (Olson et al. 2004), and survival (Anthony et al. 2006) of NSOs.

The future of NSOs in the United States may be similar to what took place in Canada. The population of NSOs in Canada decreased from an estimated 500 pairs before European settlement to only 23 adult owls in 2005 due to habitat loss, habitat fragmentation, and competition with barred owls (Hausleitner and Blackburn 2006). Concerning NSOs in the United States, Gutiérrez et

al. (2004) placed nine possible outcomes of the threat from barred owls into three categories: clearly plausible, plausible, and not plausible or not clear. Their three clearly plausible outcomes were as follows: (1) barred owls will replace NSOs throughout the range of the NSO; (2) barred owls will replace NSOs in the northern (more mesic) part of their range; and (3) barred owls and NSOs will reach a competitive equilibrium favoring barred owls in most of the range of the NSO. The extinction of NSOs in the wild is the first outcome, and it is unknown whether a threatened species could sustain the population declines as described in the second and third clearly plausible outcomes.

The 2007 Draft NSO Recovery Plan (USFWS 2007) identified barred owls as a very important threat to NSOs. The Draft Plan listed many recovery actions relative to barred owls, including establish an Interagency BDOW Working Group, analyze existing data sets for effects of barred owls on NSOs, write a barred owl Management Plan, prioritize areas of control of barred owls, and conduct barred owl control experiments.

CSO POPULATIONS AND THREATS

There are two distinct populations of CSOs. In the Sierras, the population of 1,865 cumulative territories of CSOs is largely contiguous (USFWS 2006) and appears to be stationary (Blakesley et al. 2006). Cumulative totals of all territories known to be historically or currently occupied by at least one CSO are used to indicate relative numbers, even though many of those territories probably are not currently occupied. In southern California, the 440–578 cumulative territories of CSOs occupy “islands” of high-elevation forests separated by lowlands of chaparral, desert scrub, and human development (Noon and McKelvey 1992, LaHaye et al. 1994). These islands comprise 15–20 populations with 3–270 individuals per population, and are separated from each other by 10–72 km (Verner et al. 1992, Gutiérrez 1994, LaHaye et al. 1994). These populations appear to be isolated from one another. No inter-mountain movements were documented for any of the 478 juvenile CSOs banded in the largest subpopulation of CSOs, which is in the San Bernardino Mountains (LaHaye et al. 2001). There is no complete, up-to-date analysis of population trends of CSOs anywhere in southern California. Most data for CSOs in southern California are from the San Bernardino Mountains (Franklin et al. 2004). Consistent surveying in that area was conducted only through 1998, and there

are no consistent monitoring data for any of the other subpopulations of CSOs in southern California.

The U.S. Fish and Wildlife Service (USFWS) was petitioned in 2000 (CBD 2000) and 2004 (CBD 2004) to list the CSO as a threatened or endangered species. In both 12-month findings, USFWS (2003, 2006) determined that the species did not warrant listing. In the more-recent finding, the USFWS showed that (1) CSO populations were stationary in the Sierras and, as far as is known, in southern California; (2) regulatory mechanisms and protections were adequate; (3) catastrophic wildfire posed the greatest threat to CSO habitat but the treatment of fire fuels on USFS lands in the Sierra Nevada Mountains by the Sierra Nevada Forest Plan Amendment (USDA 2004) is addressing that threat; and (4) barred owls are not a current threat. Specifically, USFWS (2006) stated: “Although barred owls may pose a substantive threat to California spotted owls at some point in time, they do not appear to pose a significant threat now or in the foreseeable future.”

For unknown reasons, barred owls have increased in numbers and distribution in the Sierras at a much slower pace than they did in northwestern California. As of April 2005, 496 barred owl detections had been recorded throughout California, only 60 of which (12%) were in the range of the CSO (Leskiw and Gutiérrez 1998, Fullerton and Meekins 2004, Jensen et al. 2004, Seamans et al. 2005, Schmidt 2006, Steger et al. 2006, P. Cranston, L. Diller, S. Farber, G. Gould, J. Keane, B. Marcot, K. Schmidt, M. Seamans, B. Woodbridge, personal communication). Fifty-seven of these 60 detections were in the northern Sierras; the three that were not in the northern Sierras were two hybrid spotted/barred owls in the Eldorado National Forest in the central Sierras (Seamans et al. 2005, M. Seamans, personal communication) and one male barred owl in Kings Canyon National Park in the southern Sierras (Steger et al. 2006). No barred owls have been detected south of San Francisco Bay in western California. If barred owls extend their range farther southward along the coast, the small, isolated groups of CSOs in southern California may be highly susceptible to negative effects from them.

CONSIDERATION OF CONTROL OF BARRED OWLS FOR CSOS

We agree with the conclusion of the recent 12-month finding (USFWS 2006) that barred owls are

neither a current threat to CSOs nor a threat to CSOs in the foreseeable future. If, just outside of the foreseeable future, barred owls build-up their numbers in the range of the CSO and become a threat, it probably would be too late to manage the problem due to the infeasibility of controlling invasive species after they have become numerous and widespread (Rejmánek and Pitcairn 2002). We view barred owl control for CSOs, if initiated soon, to be an “insurance policy” against barred owls ever becoming a threat to CSOs that also would minimize the numbers of barred owls needing control.

DRAFT METHODS FOR CONTROL

Management Options

There are a limited number of ways to keep barred owls from negatively affecting spotted owls, and Buchanan et al. (2007) present five general approaches. Our analysis of these approaches indicates that lethal control is the most practical and effective method (Table 1). Consequently, “control” herein refers to lethal control.

Control Initiation

Virtually all information we have concerning the effects of barred owls on spotted owls has resulted from incidental detections of barred owls and correlational analyses (Livezey and Fleming 2007). Three ongoing NSO/barred owl radio-telemetry studies in Oregon (D. Rock, D. Weins unpublished data) and Washington (L. Irwin, unpublished data) are attempting to provide direct data. If these studies and at least one control experiment verify that barred owls are indeed the cause of the observed negative effects, then we would have stronger proof on which to justify lethal control of barred owls for CSOs. Consequently, it seems prudent to wait for at least initial results from these studies before initiation of control of barred owls to benefit CSOs.

Control Locations

A comprehensive program to protect CSOs would require control of barred owls whenever they are found in the range of the CSO. However, politics, public sentiment, and logistics make it unrealistic to assume that barred owls would be

Table 1. Comparison of five methods to control effects of barred owls (BDOWs) on spotted owls (SPOWs).

Method	Known Techniques	Economics	Effectiveness
Habitat management to benefit SPOWs	No	Very expensive; requires large-scale management of SPOW habitat	Unknown
Supplementary feeding of SPOWs	Yes	Expensive; requires surveys to locate nesting SPOWs and repeat visits to feed SPOWs	Ineffective; BDOWs could remain and defend their territories from occupation or breeding by SPOWs
Diversionary feeding of BDOWs to move them away from areas with SPOWs	Yes	Expensive; requires surveys to locate BDOWs and SPOWs and repeat visits to feed BDOWs	Ineffective; supports reproduction of BDOWs that could later compete with SPOWs
Disruption of BDOW reproduction (e.g., oiling of eggs, removal of eggs, sterilization of adults)	Yes	Expensive; oiling or removal of eggs requires surveys to find nests of BDOWs and requires access to nests when eggs are present; sterilization requires capture of BDOWs	Ineffective; BDOWs could remain and defend their territories from occupation or breeding by SPOWs
Lethal control of BDOWs	Yes	Moderately expensive; requires locating BDOWs and attracting them to within shooting range	Very effective; eliminates competition with BDOWs

controlled throughout all forests in the range of the CSO including National Parks, state lands, and private lands. But control may be feasible in National Forest lands, where the vast majority of suitable habitat for spotted owls (and, we assume, barred owls) exists in the Sierras. Hence, control of barred owls only in National Forest lands may be adequate initially. As of 2006, only one barred owl had been detected south of the Eldorado National Forest (Steger et al. 2006), suggesting that control of barred owls in National Forest lands from the Eldorado National Forest northward would be sufficient initially. Agency biologists and volunteer birdwatchers could be enlisted to report detections of barred owls south of Eldorado National Forest and San Francisco Bay to inform decisions concerning expanding control efforts southward. Additional decisions would need to be made concerning control of barred owls in areas outside of National Forests such as in National Parks, state lands, and private lands.

Detection Techniques

Barred owls would be detected by eliciting responses using spotted owl calls or barred owl calls produced by voice or by tape recorder/speaker. As in virtually all NSO studies (e.g., Herter and Hicks 2000, Kelly et al. 2003, Olson et al. 2005, Anthony et al. 2006), the studies of CSOs in the Sierras elicit responses from CSOs by using CSO calls. In the two long-term CSO study areas (Plumas-Lassen Administrative Study/Lassen Demography Study, Eldorado Demography Study), we suggest that surveyors continue to use spotted owl calls exclusively, and that barred owls would be detected incidentally. Outside of the CSO study areas, use of barred owl calls rather than CSO calls may be preferred to decrease the chances of aggressive encounters between the species and, possibly, to increase the detection rate of barred owls.

Control Techniques

Control of barred owls could be done by individuals (herein called “agents”) from a company or agency equipped and permitted to conduct such activity. Barred owls are protected by the Migratory Bird Treaty Act (16 U.S.C. 703 et seq.), so a USFWS permit to lethally control barred owls would be necessary. Barred owls detected in CSO study areas could be reported to agents who would return to the areas in question, elicit responses using barred owl calls, and shoot the responding barred owls. The Principal

Investigators of the two CSO long-term study areas in the northern Sierras (J. Keane, personal communication, Plumas-Lassen Administrative Study/Lassen Demography Study, R. Gutiérrez, personal communication, Eldorado Demography Study) are willing to participate in this approach. Outside of these study areas, agents could both survey for and control the barred owls, which would increase efficiency by allowing the agents to control the barred owls when first detected rather than having to relocate them later. USFS conducts many project-specific surveys for CSOs throughout the Sierras, and detections of barred owls from those surveys could be directed to agents. Models of great horned owls (*Bubo virginianus*) (usually used to scare birds from gardens) with their ear tufts cut off could be used to draw barred owls within range. Use of a shotgun from within 30 m of barred owls using 7.5 shot would avoid only injuring barred owls (L. Diller, personal communication).

Other considerations include season and frequency of control, use of carcasses for other research, and coordination with agencies and the public. Season and frequency of survey and control would be dependent on the timing of the nesting season and ease of detection. We suggest that three surveys per 6-month season (March 15-September 15) would be adequate. To accommodate the waning of response as the breeding season progresses, the first survey could be done during the first 6-1/2 weeks (March 15-April 30), the second during the second 6-1/2 weeks (May 1-June 15), and the third during the last 13 weeks (June 16-September 15). Prepared data forms could be used by personnel to record date, location, sex of barred owl, etc. Carcasses could be frozen for use by researchers (e.g., DNA analysis, testing for hybrids). To lessen chances of confrontations with the public, personnel could use unmarked vehicles, and to support their authority if confrontations occur, they could wear uniforms from their company or agency. To lessen cost and, we believe, adequately cover the northern Sierras, a 3-year rotating-panel design could be used to cover the areas to be controlled (J. Keane, personal communication); that is, each of three adjacent areas would be surveyed and receive control annually on a rotating basis. A year-round Project Manager could be in charge of communications with USFS, California Department of Fish and Game, other agencies as needed, game wardens, sheriffs, private landowners, and the public, as well as implementation of the control (e.g., obtaining

permits, training agents, compliance with methods). Good communication and coordination among agencies and the public would be crucial to the success of this endeavor; consequently, we suggest the Project Manager begin these communications at least one year before any control is done. A year-round Contract Manager would be needed to hire and supervise seasonal personnel, administer the contract, and produce annual reports.

Control Costs

Cost of control is directly proportional to the area covered. We estimate the average size area that a seasonal agent could cover is approximately 9,200 ha, taking into account varying road densities, area-specific and year-specific differences in snowy and muddy road conditions, snowy and rainy weather during March–May, need for all-terrain vehicles, snow-shoeing, hiking, etc. (C. Gallagher, J. Keane, P. Shaklee, personal communication, D. Rock, personal observation).

Table 2. Estimated number of personnel to survey for and control barred owls in suitable habitat in National Forest lands in the northern and central Sierra Nevada Mountains, California.

Consideration	Area (ha)	No. Personnel
Area of control		
Total suitable habitat ^{1,2,3}	767,027	
Habitat being surveyed via CSO studies ³		
Lassen Demography Study	63,380	
Plumas-Lassen Administrative Study	38,782	
Eldorado Demography Study	14,535	
Total habitat being surveyed	116,697	
Remaining habitat requiring surveys	650,330	
No. of personnel needed to control		
Control only		
Area with CSO surveys	116,697	
Area one person could cover ⁴	40,000	
No. of areas for control only		3
Survey and control		
Area without CSO surveys	650,330	
Area one person could cover ⁵	9,200	
No. of areas for survey and control		71
Total no. of areas for control		74
Total no. of personnel needed ⁶		25

¹ The Forest Service considers suitable CSO habitat as forest stands represented by CWHR classes 4M, 4D, 5M, 5D, and 6 (Mayer and Laudenslayer 1988, USDA 2004). USFWS agrees with this classification depending on the structural condition of 4M and 4D stands (USFWS 2006). Here we include all 4M, 4D, 5M, 5D, and 6 forest stands to minimize the chance that we are underestimating areas.

² In Lassen, Plumas, Tahoe, and Eldorado National Forests.

³ U.S. Forest Service data gathered by D. Yasuda.

⁴ Assuming 4 times the area that a person could survey and control.

⁵ Assuming 15 calling stations/night/surveyor, 3 visits/station/year, 100% coverage of area, 0.5-km hearing circle around each station, 6-month field season (C. Gallagher, P. Shaklee, personal communication, J. Keane, D. Rock, personal observation).

⁶ Assuming a 3-year rotating panel design of areas to be controlled (J. Keane, personal communication).

With the methods described here, it appears that a total of 25 seasonal agents and two year-round staff employees would be required to completely cover the area (Table 2). We suggest that the first year be a pilot-study year in which only approximately 10 personnel be used as improvements are made concerning methods of survey and control. Each of these 10 personnel could be placed in one of 3-year panels situated in the northernmost Sierras, where numbers of barred owl are greatest. To minimize effects of barred owls in the CSO study areas and to take advantage of incidental detections of barred owls, three of these 10 personnel could cover the Plumas/Lassen study areas in the northern Sierras and one person could cover the Eldorado study area. Total cost would be dependent on the per-person cost of the company or agency used to do the work. In addition to the costs itemized here, USFWS and USFS would have costs associated with environmental analysis, permitting, administration, and monitoring.

ACKNOWLEDGMENTS

USFWS, National Wildlife Research Center, National Council for Air and Stream Improvement, and USFS partially supported the writing of this manuscript. USFWS funded production of the presentation given by the senior author at the Managing Vertebrate Invasive Species Symposium and his attendance at that symposium. For review and comments, we thank Darrin Thome, Vicki Campbell, Brendan White, and Jim Thrailkill of USFWS, and John Keane of USFS. The views expressed herein are those of the authors and are not necessarily those of the agencies and non-profit organization for which the authors work.

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